

# Near Term Strategy for Development of 1.2 MW Target & Horn for LBNE

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<u>Plan for beam power:</u>	<u>start at</u>	<u>eventually upgrade to</u>
As of last summer	<b>0.7 MW</b>	--> 2.3 MW
Current plan	<b>1.2 MW</b>	--> 2.3 MW

LBNE Beam Project, permanent elements designed for 2.3 MW:

- transfer line
- radiation shielding
- Decay Pipe
- Absorber (Dump)

Elements designed for 0.7 MW, needing reexamination or re-design for 1.2 MW:

- Target profile monitor
- Beam window from transfer line to target hall
- Baffle
- Target
- Horns
- Horn power supply
- Hadron monitor at end of decay pipe
- Water cooling panels for target hall shield pile (were to run dry at 0.7 MW)

## Some history:

- Had developed a 0.7 KW target + horn design more optimized for LBNE
- When LBNE re-configured to save money, reverted to NuMI style target/horn which is excellent at 1st oscillation maximum, but not as good at 2nd osc. max.; expected to produce a horn with more emphasis on 2<sup>nd</sup> osc. max. later
- At 0.7 kw, both target and horn were pushed to stress limits with reasonable but not excessive safety factor. (The headroom we had with the horn we used up increasing the current to 230 kA as compared to the existing run at 200 kA)
- For 1.2 MW beam, we need some modifications

Plan: see if modest modifications can get us to 1.2 MW.

Try minimal redesign and thus hopefully minimal cost increase.

If that does not work, will look at major modifications in design.

- A 2.3 MW target/horn system may well be less efficient at neutrino production, due to some tradeoffs to handle higher power. It probably requires major mods.
  - Doing the system in two steps can make sense.

# The attempt at modest TARGET modification

## Reduce stress by increasing the beam spot size, spread out beam

- Implies making target wider so protons don't miss target
- For higher power, also must increase size of water cooling line
- Scoping calc.: for same proton flux at center, 1.3 mm RMS -> 1.7 mm RMS.  
But limit may be outer edge of target (tension) rather than center (compression)

***Detailed MARS + ANSYS simulation needed to see what size increase required***

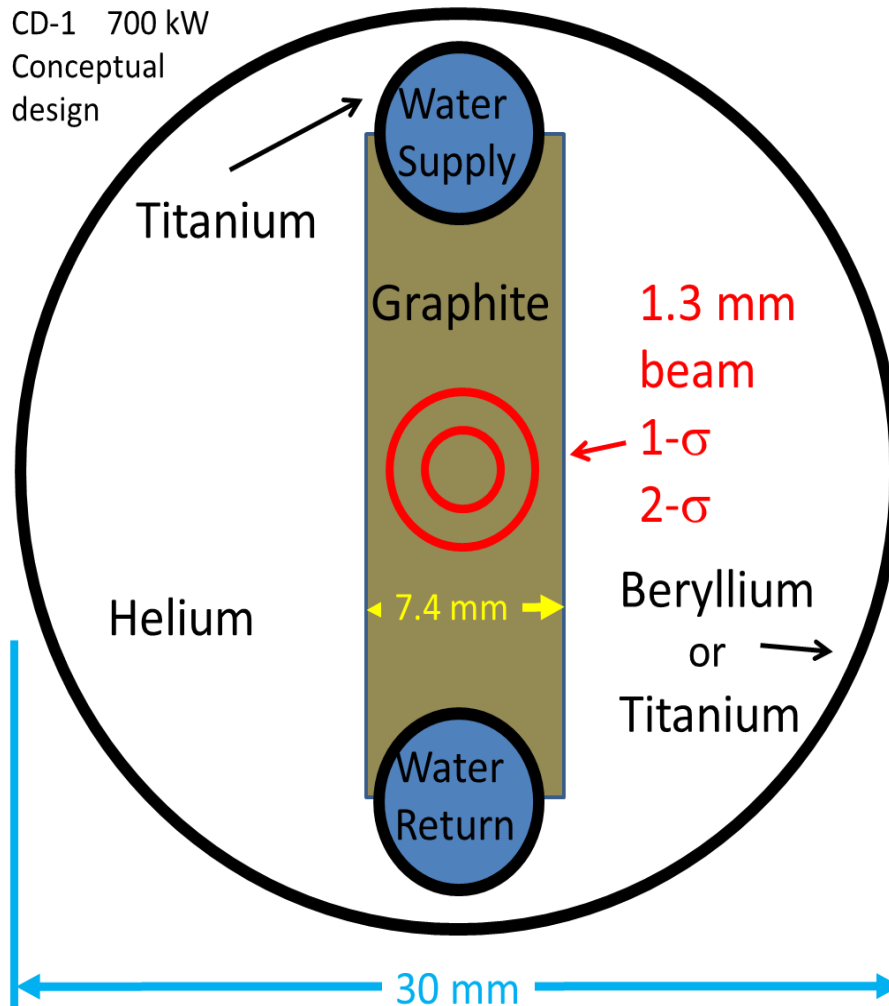
## Some expected advantages of increasing beam/target size

- Reduces stress in center of target
- Reduces radiation damage rate at center of target
- Extra showering in target may gain some flux at 2nd osc. max.

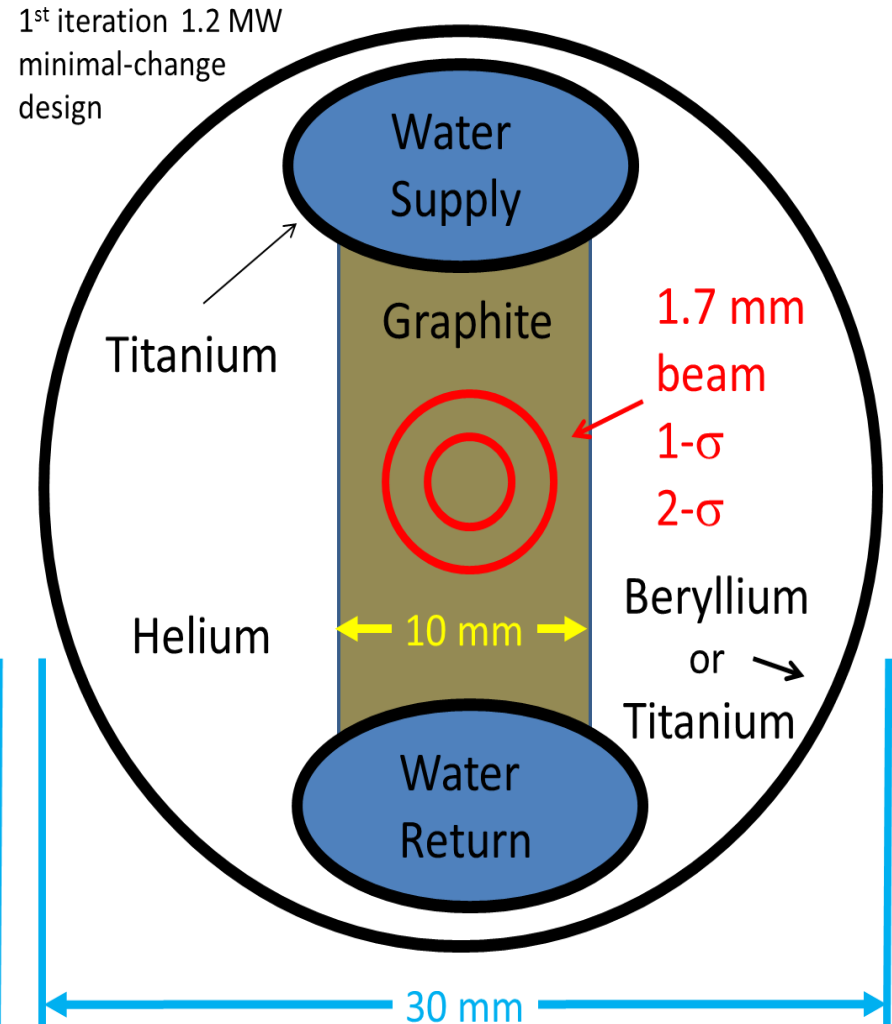
## Some expected dis-advantages of increasing beam/target size

- Extra showering in target may lose some flux at 1st osc. max.
- Extra showering deposits more beam heating in horn inner conductor
- If target cooling lines get too large, would need to increase radius of horn

LBNE  
CD-1  
0.7 MW target

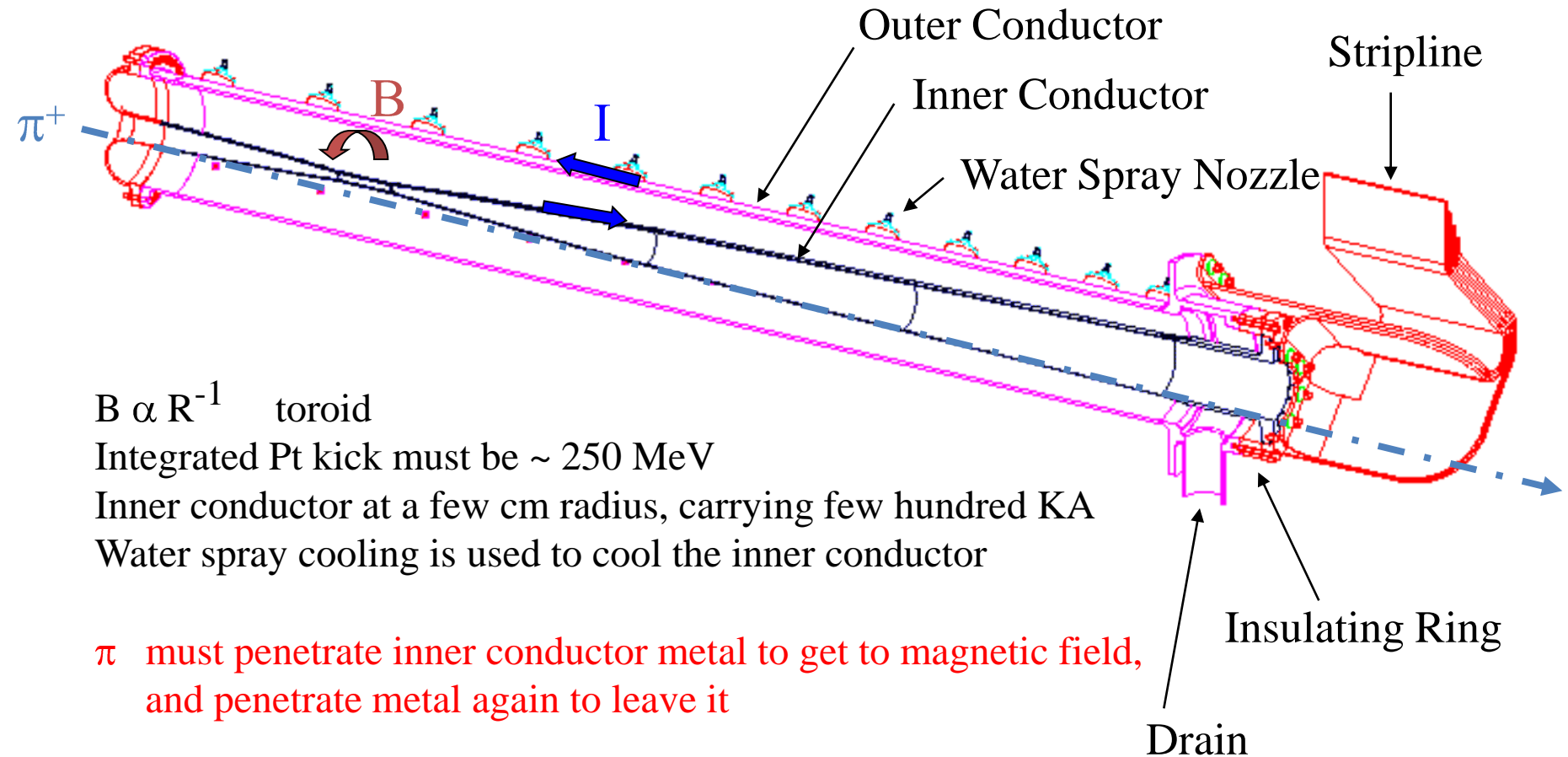


LBNE  
Zero-th iteration  
1.2 MW target



Horn:  $\pi$  focused by toroidal field between conductors

Beam-lines use 1, 2, or 3 horns in series



Inner conductor is a few mm aluminum, but penetrated at small angles

# The attempt at modest HORN modification

Horn limits come from STRESS and TEMPERATURE that ALUMINUM Inner Conductor can take

- at 0.7 Mw, beam heating : joule heating is 44% : 56%
- at 1.2 MW, make more room for beam heating by reducing joule heating with shorter pulse  
changing 2.1 msec half-sin-wave -> 0.8 ms gives same overall heating  
( insufficient flat top across beam spill would start around 0.2 ms )

Have to first see what target profile may work

- Target modifications will further increase beam heating
- Modified target might not fit in NUMI horn profile

Then input beam heating from that target into horn analysis

- Stresses are combination of magnetic field, beam heating profile, and joule heating profile

If this strategy succeeds, still requires new power supply & stripline

- We had planned to recycle the NuMI power supply to save money
- Note the pre-reconfiguration power supply was designed for 1.0 ms pulse width, similar to what we may need, so we essentially already have a design / cost estimate for that

We are months away from seeing if this minimal modification strategy works or we need substantial re-design to accomplish good neutrino efficiency at 1.2 MW.